



NASA ASTROBIOLOGY INSTITUTE ANNUAL REPORT YEAR [July 2003 - June 2004]

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Annual Reports :: Year 6 :: Impacts

Focus Groups: Impacts

Chairs:

Frank Kyte , Peter Ward

Project Progress

EXECUTIVE SUMMARY

The Impact Focus Group attempts to explore the relationship of large-body bolide impacts and the history of mass extinctions on Earth. We know that one of the largest mass extinctions of the past 500 million years (Ma) was caused by impact (the so-called Cretaceous/Tertiary, or K/T mass extinction at 65 Ma; e.g., Alvarez et al., 1980). What of the many other mass extinctions?

Mass extinction events (MEEs) significantly affect the evolutionary history of Earth's biota in two competing ways. In each of the major events of the Phanerozoic, biotic diversity was substantially reduced for several-million-year intervals following the MEE. Yet these same extinctions and diversity depressions were followed by rapid periods of diversification that, in each case, resulted in a higher global biodiversity than was present prior to the mass extinction, composed of different assemblages of organisms. The mass extinctions seem linked to diversity enhancement as well as the formation of biotic novelty. This seems to occur through the elimination of incumbent taxa, and the opening of ecological niches. Mass extinctions are thus both instigators as well as foils to evolution and innovation (e.g., Sepkoski, 1993). Clearly, impacts and MMEs play an important role in the path of biotic evolution, and are thus relevant to astrobiology.

The Impact Focus Group has concentrated on researching the two greatest terrestrial MMEs that directly preceded the K/T event — the Triassic/Jurassic mass extinction at 200 Ma and the greatest of all MMEs, the Permian/Triassic mass extinction at 251 Ma. Our work has concentrated on the analysis of rock samples collected from outcrops that record these MMEs. Focus Group co-Chairs Peter Ward (University of Washington (UW)) and Frank Kyte (University of California, Los Angeles (UCLA)) have initiated studies of samples from a number of Triassic–Jurassic (T/J) and Permian–Triassic (P/T) localities to examine whether there is evidence of bolide impact coincident with these MMEs. This work has involved several members and affiliates of the UW and UCLA NAI teams who are analyzing the trace element, noble gas, and carbon–isotopic compositions of key rock sequences.

An important new initiative has been the organization of a group of researchers for a planned consortium study of the P/T boundary at Meishan, China. This has developed as result of an earlier workshop. In February 2002, NAI partially supported a small workshop at UCLA called the Rubey Colloquium (<http://www.ess.ucla.edu/rubey/index.html>). The title of this meeting was "Impacts and the Origin, Evolution, and Extinction of Life," and the proceedings of this colloquium were published in the journal *Astrobiology* (Kyte, 2003). One of the most discussed topics at this workshop was the work of Becker et al. (2001; *Science* 291, p. 1530) who reported discovery of fullerenes and extraterrestrial noble gases in P/T boundary sediments from Meishan, China, and Sasayama, Japan. This paper was followed by technical comments by Farley and Mukhopadhyay (2001; *Science* 293, 2343a) and Isozaki (2001), with a reply by Becker and Poreda (2001). At our colloquium there was considerable discussion about this problem and the need to have these results replicated by other laboratories. There have been new developments in the P/T boundary debate since then (e.g., Basu et al., 2003; *Science* 302, 1388), but the presence or absence of an extraterrestrial signature in the P/T boundary in China remains an important problem. Meishan is the type section and possibly the best-preserved marine P/T boundary. It's fair to say that there are still many skeptics as to whether there is an extraterrestrial signature in Meishan rocks. This will probably remain the case until the results of Becker et al., (2001), can be reproduced by other labs. The main purpose of this consortium is to organize a group of interested scientists to make a good faith effort to try and collect the best set of samples possible from Meishan, and to try to reach a conclusion as to what are the chemical and mineralogical characteristics of the Meishan boundary section.

We are currently organizing a sample collection party, which will be supported by NAI and the Impact Focus Group to collect samples. Jin Yugan of the Nanjing Institute of Paleontology has headed an intensive effort to obtain large quantities of very fresh samples from the quarry at Meishan. This has been accomplished by obtaining a drill core across the boundary and by creating fresh quarry faces from which very fresh samples can be collected. These samples are being curated by Jin in Nanjing. Our main contacts with Professor Jin are Doug Erwin (Smithsonian) and Sam Bowring (Massachusetts Institute of Technology (MIT)). We currently plan a sample collection party in Fall 2004 including Kyte, Erwin, and Bowring to collect samples, with Ward and Becker (University of California, Santa Barbara) to act as observers and advisors to the sample collection. Rock samples will be prepared at the Smithsonian by Kyte, Erwin, and Bowring for distribution to several labs for analysis. To date, we have commitment from at least 12 research labs to examine various characteristics of the chemical, isotopic, paleontological, and mineralogical composition of these samples.

We hope that this consortium study will play an important role in determining whether a large-body impact, or other extraterrestrial event played an important role in the P/T boundary MEE. If this consortium effort is successful, it could set a standard for interlaboratory analysis of key samples of important events in the history of life.

References :

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FOCUS GROUP DESCRIPTION & ACTIVITIES

Analyses are in progress to examine the trace element, noble gas, and carbon–isotopic compositions of key rock sequences from selected P/T and T/J boundaries sections. We have also made significant progress in organizing a consortium group of at least 12 research labs to analyze P/T boundary rocks that will be collected from Meishan, China, in Fall 2004.

Roadmap Objectives

- **Objective No. 4.3: Effects of extraterrestrial events upon the biosphere**